SYNOPSIS for Ph. D.

1. Title of Dissertation: Characterization of Suiting Fabric produced by Ring and Compact yarns

2. Name of Department: Textile Technology.

3. Name of Programme: Ph.D. (Textile Engineering)

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5. Date of Registration:

6. Expected Completion Date: Three years

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Abstract of proposed work plan:-

Since long ago, a lot of developments have been taken place in ring spinning but introduction of compact spinning has changed all aspects of advancements in spinning and thereby offers manifold benefits so as to provide superior quality of the yarn for different applications.The proposed experimental work is aimed to develop better quality of woven fabric fulfilling the requirements of suiting application by using different types of double yarns such as ring, compact and hybrid (Ring Compact) double yarns as warp and weft combinations along with different pick density. Different types of double yarns will be produced by varying doubling twist from ring and compact single yarns of different twist. After manufacturing of different types of doubled yarns, one type of double yarn offering best results will be selected from each category of double yarn (Category A – Ring Ring Double yarn, Category B – Compact Compact Double Yarn, Category C – Ring Compact Double Yarn / Hybrid Double yarn) to develop various types of woven fabrics as stated above. Subsequently, grey woven fabrics thus developed will be chemically processed and analyzed to find out best type of the suiting woven fabric.

1. INTRODUCTION

The ultimate goal of spinning technologist is focused on higher productivity, combined with adequate yarn quality. Hence, the ring spinning system has gone through tremendous improvements during the last decades. There have been a lot of developments in ring spinning in the past but the development of compact spinning has changed all aspects of advancements. This is the development, whose advantage are not limited up to the extent of quality and productivity elevation; rather it is multidirectional and also covers the sphere of subsequent process of weaving, knitting and dyeing with tremendous and significant increase in productivity.

In conventional ring spinning, the zone between the nip line of the pairs of the delivery rollers and the twisted end of yarn is called the “Spinning Triangle “. This represents the most critical part of the ring spinning system. In this zone, the fibre assembly contains no twist. The edge fibre move out from this zone and make little or no contribution to the yarn tenacity. Furthermore, they lead to the familiar problem of yarn hairiness. In compact spinning, the spinning triangle is almost eliminated and almost all fibres are incorporated into the yarn structure under the same tension. This lead to significant

advantages such as increasing yarn tenacity, yarn abrasion resistance and reducing yarn hairiness. The compact spinning method forms a different yarn structure. The most evident properties of these yarns are their high breaking strength, high elongation and low hairiness. Other yarn properties such as yarn unevenness and thin / thick places etc. are comparable to the conventional ring – spun yarn. The structure of the compact spun yarn offers many advantages in the further yarn processing such as reduction in size paste amount, increase in weaving efficiency due to decrease in the fibre fly. As a result of improvement in yarn structure, various compact spinning designs by different textile machinery manufacturers are in common practice.

In spinning, the purpose of doubling is to join together two or several yarns to give them a twist that improves the strength and evenness than can be obtained in a single yarn of the same count. So, doubling is a value addition process which enhances the strength and uniformity. There is reduction in yarn hairiness after doubling due to entrapping of the protruding fibres between constituent yarns.

Twist plays an important and significant role on the yarn quality and its production. It provides the cohesion between the fibres and gives strength to the yarn, further, the amount of twist plays a vital role for finished consumers good which determines appearance, durability and serviceability of fabric.

The physical properties and the appearance of the cloth depend to a great extent upon the weave. The strength, elongation, tear resistance, fabric assistance, air permeability and texture are some of the properties which may be varied by changing the weave. Further, the clothing comfort depends upon the external climatic conditions along with the type of clothing and fabric weave structure.

2. REVIEW OF THE LITERATURE AND DEVELOPMENT IN THE SUBJECT

Jyoti Ranjan Dash et al. [1] studied the properties and processibility of compact yarns. They have studied the influence of winding speed on the ring yarn as well as compact yarn properties. At the end of the study they reported that the compact yarn shows excess packing density and tenacity owing to less CV% of the tenacity in relation to the ring yarn. The compact yarn also shows minimum number of imperfections. However after winding, the compact yarn shows high hairiness as compared with the ring yarn. Further, quality of the compact spliced yarn was found superior than that of the ring yarn.

Kun Yang et al. [2] studied the structure and properties of low twist short staple single ring spun yarns. In this research, they studied the performance of modified technique for

manufacturing single ring yarn along with low twist and relatively more strength. The results shows that the modified ring yarns structure and properties differ from that of conventional ring yarn.

Ashvani Goyal et al. [3] made comparative study of ring and compact spun yarns. In the experimental work, they compared ring and compact yarns made from cotton and polyester fibre with the aid of different compact spinning system. The results revealed that the properties of compact yarns such as strength, elongation, hairiness, unevenness etc. are superior as compared with the ring yarn. As far as compact spinning systems are concerned, the RoCoS compact yarn exhibits low percentage change for packing density, diameter and tenacity but shows higher fluctuation in elongation when compared with compact yarns spun by Zinser and Sussen compacting systems.

Harald Schwippl et al. [4] studied on COM 4 yarns in weaving and fabric design. In this study, they observed that the application of COM4 yarns in weaving have large scope so as to ensure improvements throughout the entire manufacturing process in terms of the quality as well as economy. Moreover, the compact yarns are also very much prone for attracting the market with new fabric designs and defect free fabric quality.

Demet Yilmaz et al. [5] made comparative study of compact-jet, compact and conventional ring-spun yarns. In this experimental study, they compared yarn properties manufactured by using three different yarn spinning systems such as ring, compact and compact-jet. Further, they found that properties of the compact-jet yarn are not like that of the conventional ring and compact yarns. The compact-jet spinning system shows better results on yarn hairiness. Also, compact-jet yarn found much better compared with other yarns.

G. K. Tyagi et al. [6] studied compact ring and compact spun yarn fabrics: Part-II- Effects of spinning variables on comfort properties. In this work, they investigated the influence of spinning conditions on the comfort properties of cotton woven fabrics. During the study, they observed that the yarn structural variant effects on the comfort properties of cotton fabrics. As a result of the modification in the yarn hairiness, packing co-efficient and diameter, the fabric comfort is affected by the twist factor and the spindle speed. Also, it was found that the compact yarn fabrics show poor thermal resistance, better air and water

vapor permeability and lower wickability and absorbency as compared with that of the ring yarn fabrics.

Alsaid A. Almetwally et al. [7] made comparative study of mechanical properties of the fabrics woven from compact and ring spun yarns. The results revealed that the mechanical and physical properties of the compact spun yarns significantly differ as compared with the ring spun yarn because of the elimination of the spinning triangle in compact spun yarns. Further, the tensile strength, air permeability and stiffness of the fabric made from the compact yarns is superior as compared the fabric made from the ring spun yarns.

Alsaid A. Almetwally et al. [8] studied the comparison between physical properties of ring spun yarn and compact yarns spun from different compacting systems. They studied the comparison with the help of 3 different compacting systems namely Rieter (K44), Toyota (RX- 240) and Sussen (Fiomax). At the end of the study, they reported that the compact spun yarns differ significantly with regard to their physical and mechanical properties. Moreover, the compact yarns also exhibits superior quality as compared with the ring spun yarns.

S Dhamija et al. [9] studied the performance characteristics of mercerized ring and compact spun yarns produced at varying level of twist and traveler weight. The ring and compact spun yarn properties were characterized by changing the twist factor, linear density and traveler weight. In the study, they investigated that the ring yarns are softer because of the low flexural rigidity as compared with the compact yarn. However, the compact yarn shows better result with regard to the tensile strength, loop strength, knot strength, breaking extension and abrasion resistance. Moreover, the positive effect of the mercerization was predominantly observed in case of the compact yarns along with the low twist factor spun yarns.

Mitsuo Matsudaira et al. [10] studied the changes in dynamic drapability of polyester fabrics with weave density, yarn twist and yarn count obtained by regression equation. The influence of weave density, yarn twist and yarn count was studied on the different parameters of polyester fabrics such as Drape Increase Coefficient(Dr), Revolving Drape Coefficient at 200 rpm (D200) and Dynamic Drape Coefficient at sewing motion(Dd). It was

found that the values of Dr and Dd vary with the variation in the yarn twist. D200 parameter shows very little change.

Palanisamy Ganesan et al. [11] studied the influence of twists on dimensional stability. In this work, they studied the influence of twist direction and relaxation on dimensional stability of the fabric by varying the arrangement of the warp and weft combinations of S and Z twist yarns. The study reveals that the Z warp and S weft yarn combination shows less shrinkage % as compared with the other type of the combinations.

M. Matsudaira et al. [12] studied the effects of weave density, yarn twist and yarn count on fabric handle of the polyester woven fabrics by objective evaluation method. The study was carried out to understand the influence of yarn twist, weave density and yarn count on handle property of polyester fabric. Through the study, they revealed that “Koshi” and “hari” reduces whereas “Shinayakasa” and “Shari” increases with increase in the twist with regard to dechine. Further, all the primary handles increases a little with increase in the twist for yoryu. As twist increases, “Kishimi” of yoryu significantly increases.

A. Alamdar-Yazdi et al. [13] studied the effect of yarn twist direction on the formability of woven fabrics. In this study, they investigated the effect of yarn twist on the formability of woven fabric. They manufactured 28 plain woven fabrics with the help of solo spun yarn as warp and weft. The results revealed that the fabric with z twist warp and z twist weft shows higher formability as compared with the fabric with z twist warp and s twist weft thread.

Sadaf Aftab Abbasi et al. [14] studied Characterization of low twist yarn: effect of twist on physical and mechanical properties. In this experimental work, the yarns with three different counts (30, 40 & 50 tex) were produced along with four different twist namely 170, 190, 210 and 230 TPM for each to understand the influence of twist on physical and mechanical properties of low twist yarn. It was found that the yarn of 50 tex having 230 TPM exhibits higher yarn strength in relation with other yarn counts and twist levels. In addition to this, improvement in yarn evenness property was seen when there was reduction in twist.

Ayano Koyrita Banale et al. [15] studied the effect of yarn twisting and de- twisting on comfort characteristics of fabrics. In this research work, they studied the influence of yarn twisting and de-twisting on the comfort property of the fabric. For this work, nominal yarns

of 23 tex with 669 tpm and 15 tex with 827 tpm were produced. Moreover, one more set of yarns with excess twist of 197 tpm and 276 tpm were produced for 23 tex and 15 tex yarns respectively. Further, the de-twisting process was used for removing out the excess twist inserted in 23 tex and 15 tex yarns and it was called as modified yarns. At the end of the study, it was found that the modified yarns exhibit higher yarn diameter, softness and less flexural rigidity in relation to that of the nominal yarns. Further, it was seen that the fabric with modified yarns (de-twisting process) shows positive effect with respect to fabric thickness, tightness factor, compressibility and wicking height. But, it shows reduction in other properties such as air permeability, stitch density and water vapour permeability.

A. F. W. Coulson et al [16] studied thoroughly Doubled Yarns in five parts. In their exhaustive study, they had examined the influence of single yarn twist, doubled yarn twist on the characteristics of doubled yarn. In the first part, they critically studied doubled yarns twisted S on Z and produced from medium staple American cotton, a carded Sakel cotton and viscose rayon staple wherein they investigated influence of single and double yarn twist on double yarn properties such as strength, elongation, snarling etc. In second part of the study, they studied the influence of doubling yarn tension on the 80s/2 double yarn properties. For the study, the tension during doubling process was changed by changing the parameters such as traveler weight, ring diameter and spindle speed. In the third part, the study was conducted to examine the combined influence of doubled yarn tension factor along with the single and double yarn twist. Yarns were twisted with S on Z and Z on S twist. In fourth part of the study, different cabled yarns were considered and the doubling tension was only varied to understand its influence on the cabled yarn properties. At the end, in the fifth part of their study, they studied the influence of twist direction inserted at single, doubled and cabled yarn manufacturing stages on the cabled yarn properties used for sewing application.

G. K. Tyagi et al. [17] studied the contribution of doubling to the characteristics of polyester-cotton ring and rotor spun yarns. In this research work, they found that the PC rotor yarns exhibits significant improvement in tenacity, elongation at break and unevenness after doubling. Also, they observed that the improvement governed by the polyester content, single and double yarn twist in the yarn.

Dariush Semnani et al. [18] studied Wrinkle fabric appearance in uniform waveform by hybrid yarns. In the experimental work, they produced the plain and twill fabrics with different types of hybrid cotton high shrink polyester yarns. Waveform appearance was tried to develop on the fabric surface by using heat treatment process. It was revealed that, the fabric samples produced from the core spinning yarns yarn and twisting methods showed higher strength in the warp direction. Further, the fabric thickness increase in all the samples due to the application of heat treatment process.

Pelin Gurkan Unal [19] investigated some handle properties of fabrics woven with two folded yarns of different spinning systems. In the study, he has observed the influence of different spinning methods like ring, rotor and vortex, and twist direction of yarn on handle properties of the fabric. It was revealed out from the study that the handle properties of the fabrics made up from the ring double yarns are best than that of made up from rotor and vortex double yarn.

F. Zaghouani et al. [20] critically compared the quality of open end, ring and hybrid folded yarns of cotton. In this experimental work, they have studied the influence of different spinning and doubling parameters on the quality of ring, open end and hybrid doubled yarn. It was observed from the study that the doubling twist factor has the most important influence on the ring, hybrid and open end doubled yarn. Further, the yarn linear density is also substantially affect the ring double yarn but it has no influence on open end and hybrid doubled yarns.

S. M. Ishtiaque et al. [21] studied the structural and tensile properties of ring and compact plied yarns. In the study, they investigated the influence of doubling on the physical properties of ring and compact yarns. At the end of the study, it was found that the structural parameters such as fibre extent, spinning-in-coefficient, fibre pair overlap length, packing density enhanced and migration parameters reduces after doubling for both ring as well as compact yarns. After doubling, ring spun yarn showed higher increase in tensile strength and lower decrease in braking elongation as compared with the compact yarn. Doubling also reduces hairiness for both ring and compact yarns. Further, ring spun yarn shows high extent of hairiness reduction on doubling.

N. R. Halari et al. [22] studied the effect of twist level and twist direction of core (double) yarn on dref-3 spun yarn. They had carried out the study to understand the behavior of friction spun yarn by adding doubled yarns as core with diversity in twist level and twist direction. It was concluded from the study that the twist direction of the doubled yarn used as core has significant effect on the breaking force and elongation of friction yarn.

J Thanikai Vimal [23] studied the effect of weave parameters on air resistance of woven fabrics produced from compact doubled yarn. In the study, the influence of weave parameters such as crossing over firmness factor (CFF), floating yarn factor (FYF), fabric firmness factor (FFF) and geometrical properties was studied on air resistance. At the end, the result indicates strong correlation among CFF, FYF and FFF with air resistance. Fabrics with long float showed lower air resistance whereas the fabrics without float shoed higher air resistance. Thickness was also found to have correlation with air resistance.

B. K. Behera et al. [24] studied comfort properties of fabrics woven from Ring, Rotor and friction spun yarns. In this study, they have compared the comfort properties of the fabrics woven from ring, rotor and friction spun yarns. Further, the influence of weave on comfort properties of the fabrics also studied. The fabrics woven from ring spun yarn showed best tactile comfort and the fabrics produced from friction spun yarn showed best thermal comfort. A twill woven fabric was found more superior in terms of all the aspects of comfort as compared with plain woven fabric.

A. Mukhopadhyay et al. [25] evaluated comfort properties of polyester viscose suiting fabrics. In the study, comfort properties of polyester viscose fabrics woven with two different weaves (plain & twill) were studied. The results indicate that Total Hand Value of twill woven fabrics showed different trend and changes with change in polyester content than that of plain woven fabrics. With increase in polyester content, the thermal insulation and water vapour resistance increases.

B. K. Behera et al. [26] studied light weight worsted suiting fabrics. In the study, it was found that a lower drape coefficient is favourable for worsted fabrics with respect to appearance. But, very less value of drape coefficient may be harmful to fabric appearance. Finer fibres for the same linear density of the yarn generates more cohesion between the

fibres tend to give higher bending rigidity. This gives increase in fabric formability and also offers better fabric appearance.

A. Das et al. [27] studied the frictional characteristics of woven suiting and shirting fabrics. In this work, they have studied frictional characteristics of shirting and suiting woven fabrics produced from different blends and constructional parameters. It was concluded from the study that fabric to fabric friction affected by several factors such as fibre type, blend type, yarn structure, fabric structure, crimp, compressibility etc.

Gulcan Sule [28] investigated bending and drape properties of woven fabrics and the effects of fabric constructional parameters and warp tension on these properties. In the study, they investigated influence of weft density, weft count and warp tension on bending and drape properties of woven fabrics. It was found that the fabric woven with coarser weft yarn and high weft densities shows higher values of bending rigidity. Further, with increase in warp tension, bending rigidity of the fabric increases in warp direction. In addition to this, drape coefficient of the fabric increases with increase in weft density and as the weft yarn becomes coarser.

Hakan Ozdemir et al. [29] studied the effect of fabric structural parameters on the tensile, bursting, and impact strengths of cellular woven fabrics. In the research work, tensile, bursting, impact strengths and behaviour against the impact of cellular woven fabric was investigated and compared with those of the plain woven fabrics. It was found that tensile strength of the plain woven fabric is better than that of cellular woven fabrics, whereas the bursting and impact strength of the cellular woven fabric is better than that of the plain woven fabrics.

S. M. Ishtiaque et al. [30] studied the clothing comfort and yarn packing relationship: Part II – Transmission characteristics of fabrics. In the study, the influence of ring frame process parameters having effect on yarn packing, like yarn twist, spindle speed and draft at ring frame on transmission characteristics of the fabrics was investigated. The result shows that ring frame process parameters have direct relationship with the air permeability and with the increase in ring frame parameters the fabric transmission parameter increases.

Koviljka A Asanovic et al. [31] studied quality of clothing fabrics in terms of their comfort properties. In the research work, comfort properties with respect to quality of various clothing woven fabric reported. It was found that cotton fabrics have lower value of volume resistivity, air permeability and compressive resilience and higher values of effective dielectric permeability and compressibility as compared to the cotton and polyester fibre blends. Further, it showed that the fabric comfort property is depend upon fabric structure and fabrics surface condition. Moreover, it found that the cotton fabric shows better comfort quality than that of cotton polyester blend fabric.

S. Mhetre et al. [32] studied the effect of fabric structure and yarn to yarn liquid migration on liquid transport in fabrics. In this work, cotton and polyester fabrics were studied with respect to wicking property. It was concluded that wicking behavior of fabrics is governed by wicking behavior of yarns, thread spacing etc.

K. Doustar et al. [33] studied the effect of fabric design and weft density on bagging behavior of cotton woven fabrics. In the study, the influence of weave and weft density was seen on the bagging behavior of the fabrics with the help of FAST System. The result shows that 2/2 twill structure gives low shear rigidity, highest formability and hence high bagging behavior as compared with other weaves like plain,3/1 twill and hopsack.

Selin Hanife Eryuruk et al. [34] studied the effect of weave construction on tear strength of woven fabric. In this tear strength of woven fabric was analyzed for four different weaves as tear strength has relation with fabric serviceability. The results indicate that the fabric weave affects tearing strength.

Sheraz Ahmad et al. [35] studied effect of weave structure on thermo-physiological properties of cotton fabrics. In this relationship between fabric weave and fabric comfort properties reported. It was found that, plain fabric showed highest thermal resistance and hence it is suitable for cold climatic conditions. 2/2 Matt weave showed lowest thermal resistance and it is suitable for hot climatic conditions.

The above literature review indicates that the researchers have done ample amount of work in the subjects of spinning systems, yarn twist level, twist direction, yarn doubling etc., with respect to its influence on characteristics of single and double yarn which in turn

affects the fabric properties. In addition to this, the effect of fabric weave and other parameters have also been studied in detail in view of the fabric properties. Some studies have been also reported specifically in relation to the comfort properties of suiting fabrics woven from ring, rotor and friction spun yarns and frictional characteristics of suiting fabric.

By considering the literature review, it is found that there is scope to investigate the doubled yarn properties by undertaking combined study of spinning system, single yarn twist level and doubling twist level. Further, we can also studythe fabric weaving with regard to the behaviour of ring, compact and hybrid doubled yarn as warp and weft combinations and pick density.

3. OBJECTIVES OF THE STUDY

- To study the effect of ring and compact single yarn twist on the properties of double yarn.
- To manufacture ring, compact and hybrid double yarn by varying the twist.
- To develop the woven fabric from double yarns.
- To study the characteristics of finished suiting fabric.

4. METHODOLOGY

4.1 Raw Material

The material will be procured in the form of the single yarn from suitable yarn manufacturer.

4.2 Availability of Research Facilities Required

The required machineries set up for carrying out the experimental work is available at DKTE Society's Textile & Engg. Institute, Ichalkaranji and also in nearby textile industries.

4.3Double Yarn Manufacturing

Different types of double yarns such as ring, compact and hybrid double yarnswill be produced by varying the twist from ring and compactyarns of different twist. After manufacturing of different types of doubled yarns, one type of double yarn offering best results will be selected from each category (Category A – Ring Ring Double yarn, Category B – Compact Compact Double Yarn, Category C – Ring Compact Double Yarn) to develop woven fabrics.

4.4 Yarn Testing

The double yarns produced will be tested for the following different yarn tests.

- Count & CV
- CSP
- Twist & CV
- Diameter
- Unevenness
- Imperfection
- Hairiness Index
- S3 Value
- Strength
- Elongation
- Friction
- Abrasion
- Other relevant tests, if any

4.5 Fabric Manufacturing

Different types of grey woven fabrics will be developed on the rapier loom for suiting application by using three types of double yarns, one selected from each category as warp and weft combination and by varying the pick density.

The grey woven fabrics produced will be chemically processed for developing finished fabrics.

4.6Fabric Testing

All different types of finished woven fabricwill be tested for the following different fabric tests.

A) Structural Properties

- Warp & Weft thread densities (EPI/PPI)
- Warp & Weft crimp levels
- Cover Factor
- Fabric Thickness
- Tensile Strength

- Tear strength
- Abrasion resistance
- Pilling resistance

B) Comfort related Transmission properties

- Air permeability
- Water vapor permeability
- Thermal Insulation Value
- Kawabata Hand Evaluation System

C) Aesthetic Properties

- Stiffness
- Drape
- Crease recovery

The data obtained by carrying out the experimental study will be analyzed by using suitable statistical tools for confirming the proposed hypothesis.

5. IMPORTANCE OF THE STUDY

Clothing is an integral part of human life and has number of functions: adornment, status and protection. Intensive growth of world population indicates the need of making clothing fabrics that comply with the requirements of a large number of consumers. It is not enough for clothing fabric to have only a good ornamentation and durability. The fabric should have good comfort properties also. Suiting fabric has been used worldwide for different applications like trousers, bottom wear etc.In the past, suiting fabric was produced at larger extent mainly by using ring yarn. However, after introduction of compact spinning technology, use of compact yarn for producing different types of the fabrics gradually started to increase as compact yarn expected to exhibits enhanced yarn properties in relation to the ring yarn. Further, use of compact yarn is also increasing for producing suiting fabric at national and international level. Therefore, the advent of new type of yarns such as compact yarns make it imperative to study the potential of doubling these yarns with a view to use them to maximum extent specifically for producing suiting fabric. Designer of fabric products also look to be benefited from doubling of compact yarn. The proposed study highlights the suitability of ring, compact and hybrid yarns produced at doubling stage by varying the twist for manufacturing of the best quality double yarn for

suiting application. Moreover, the study will also help to optimize twist with regard to the better quality of single yarn and double yarn manufacturing.

The proposed study of manufacturing finished suiting fabric by using different types of double yarn as warp and weft combination and different pick density will help to investigate best type of woven fabric offering better performance essential for suiting application. In addition to this, the study will also help to optimize the pick density for producing best quality of the suiting fabric.

6. PROPOSED WORK PLAN / FORMULATION AND STRUCTURE OF STUDY

YEARWISE PLAN OF WORK AND TARGETS TO BE ACHIEVED

The proposed work plan along with the time line to complete the entire experimental work is as given below.

Sr. No.	Activity	Time Period (Months)
1	Procurement of Ring & Compact Single Yarn of different twist	1.0
2	Testing of Ring & Compact Single Yarns	1.0
3	Manufacturing of Ring, Compact and Hybrid Double yarn of different twist	6.0
4	Testing of Double yarns	1.0
5	Statistical analysis& Results and Discussion (Double Yarns)	4.0
6	Woven Fabric Manufacturing with various warp & weft combinations & with different pick density	6.0
7	Finishing of Grey Fabric	2.0
8	Testing of finished fabric samples	1.0
9	Statistical Analysis	1.0
10	Results and discussion (Woven Fabrics)	6.0
11	Conclusion	1.0
12	Thesis Write up	6.0

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